Cross Creek-

Monitoring Station- SC551
USGS Gaging Station- None
Included area-
    HUC 8: 10270102
        HUC 10: 06
            HUC 12: 01, 02, 03, 04

Streams Flowing to Monitoring Station-

Name	Segment #
Cross Creek-	12
Bartlett Creek-	55
Little Cross Creek-	61
Illinois Creek-	62
Salt Creek-	88
Sullivan Creek-	89
Coryell Creek-	94

Unmonitored Downstream-

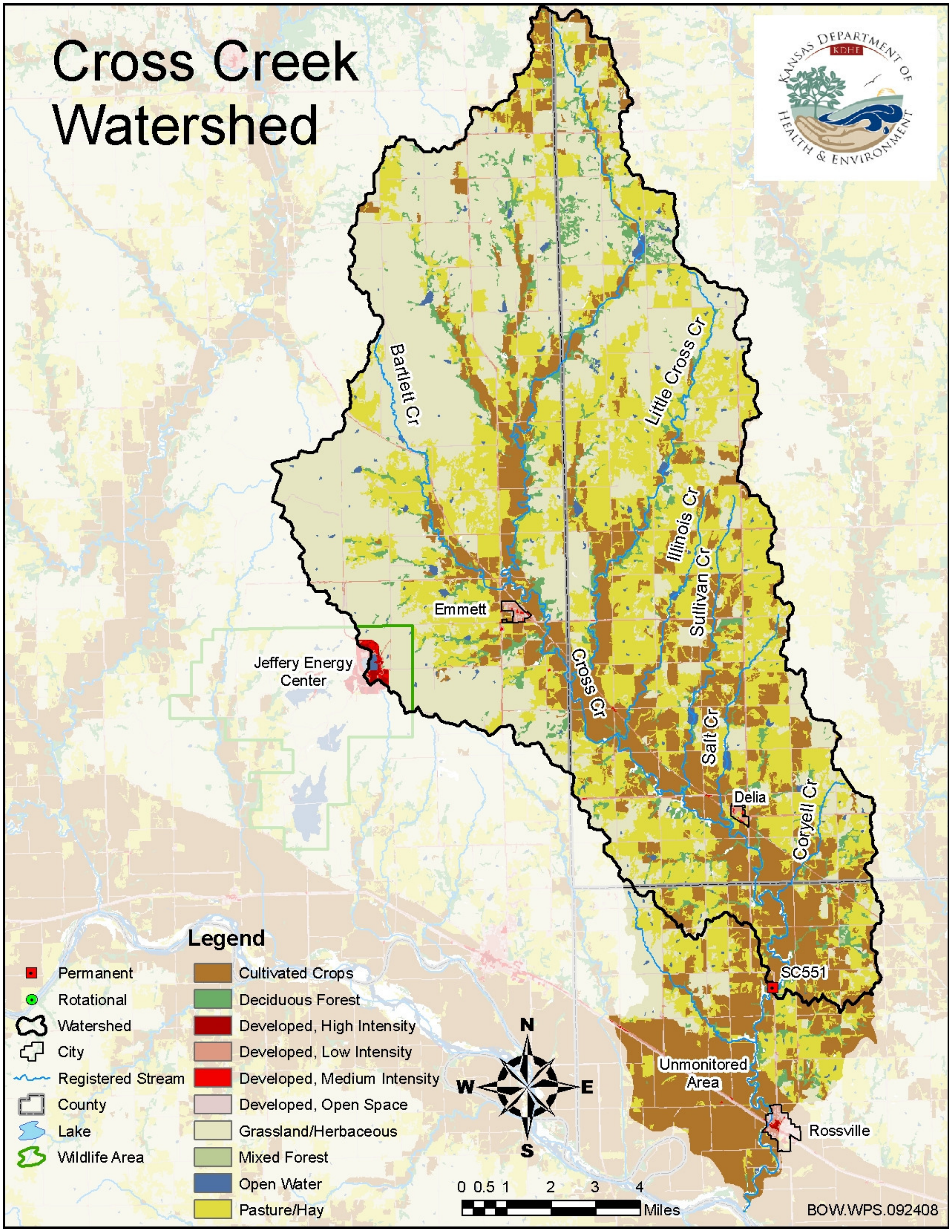
Cross Creek-	12
Snake Creek-	95

Land use in Monitored Area-

Permanent Grass	69.98%
Cropland	18.63%
Forest	6.22%
Developed Land	4.25%

Counties- Jackson, Pottawatomie, Shawnee
Cities- Delia, Emmett; Rossville lies along Cross Creek downstream of the monitored area
Cross Creek Watershed District – Includes the entire watershed
2000 Population- 1,660
Kansas House Districts-50, 51 & 61
Kansas Senate Districts- 1 & 18
Monitored Watershed Size- 154 square miles
Unmonitored Downstream Area- 21.5 square miles
2008 303(d) impaired waters- *E. coli* Category 3 (some evidence of impairment, but insufficient data to determine if water quality criteria are met)
TMDLs- None
NPDES Permitted Facilities- Delia MWTP (M-KS10-OO01), Emmett MWTP (M-KS16-NO01), Cross Creek Estates Mobile Home Park (C-KS16-NO02), Hamm (I-KS10-PO02)
Permitted Confined Animal Feeding Operations-2

Animal Type	Total Animals
Beef	600
Swine	510



Overview map of the Cross Creek watershed. Land use from the 2001 National Land Cover Dataset.

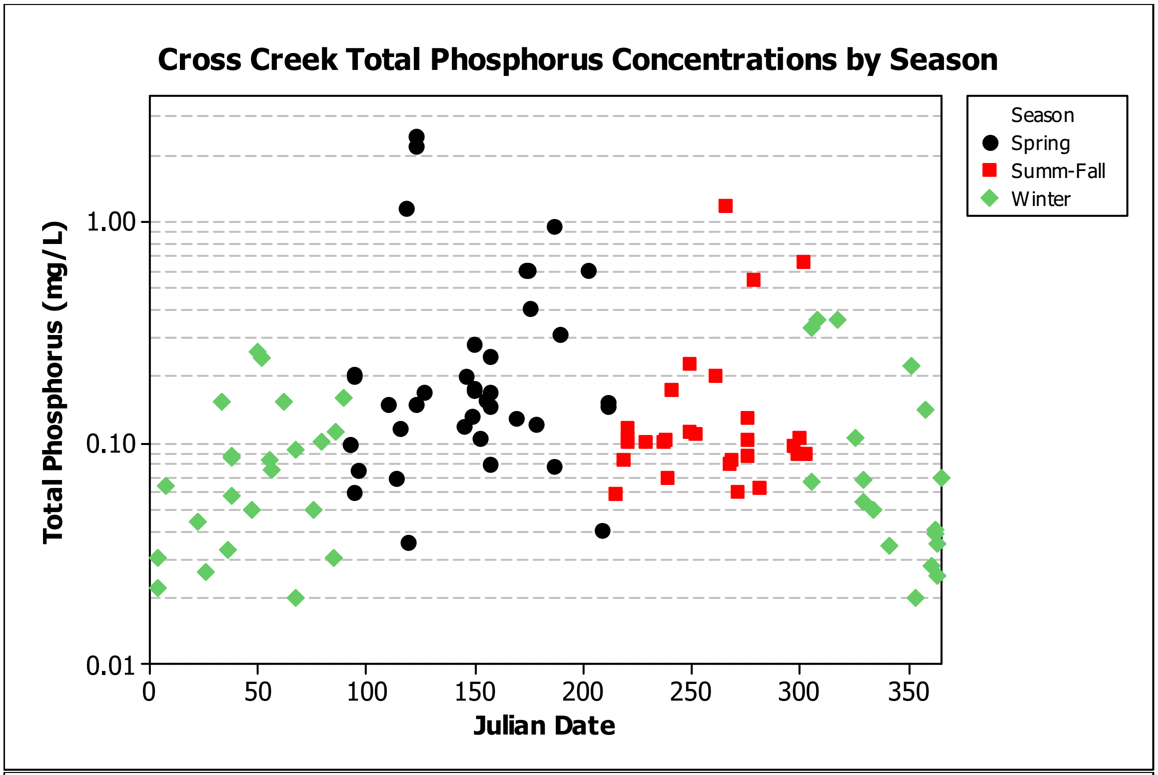
Stream Chemistry-

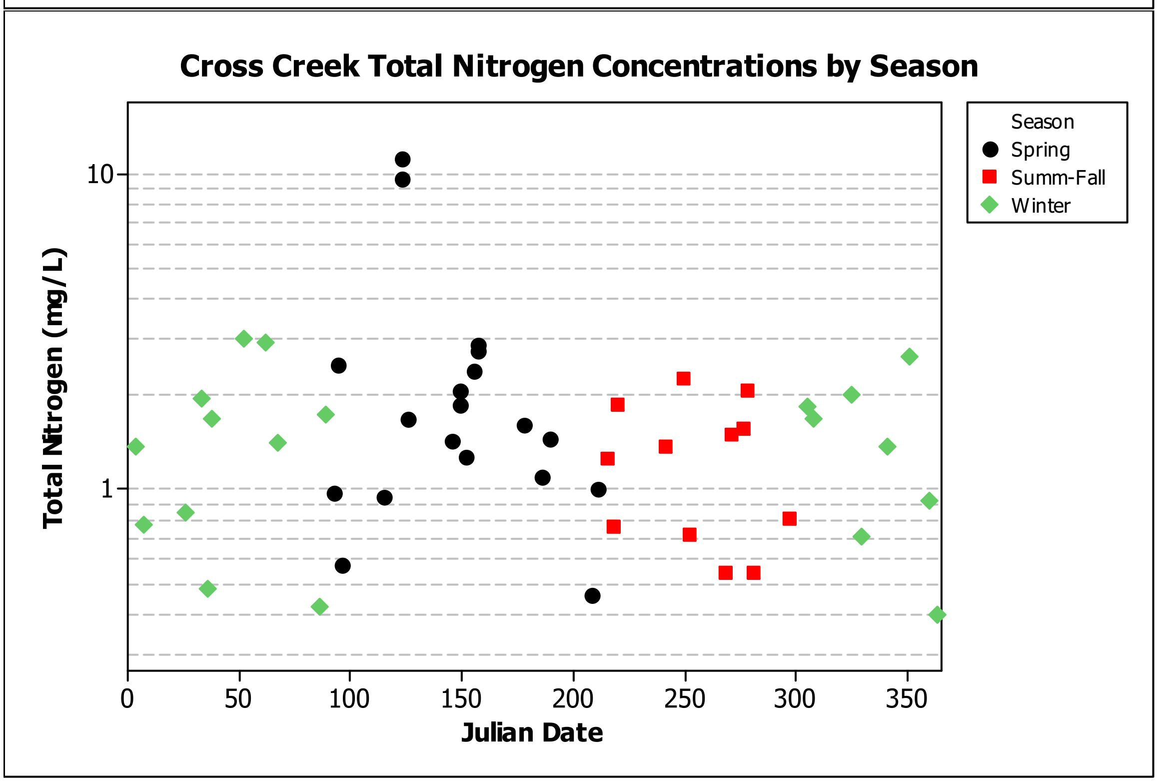
Cross Creek has a very poor ranking for TSS and TN when compared to other stations in the Upper and Middle Kansas, and moderate rankings for *E. coli* and TP. Cross Creek experiences its highest pollutant concentrations during the spring season (April-July) some reductions during the summer/fall (August- October), and the lowest concentrations during the winter (November-March). The seasonality is strongest for TP & TSS, while TN & *E. coli* show elevated spring concentrations with wide variation across the remainder of the year. While Cross Creek does not have an active gaging station, these results are consistent with similar results in other gaged watersheds for areas experiencing runoff and high flow event contamination for sediment and phosphorus. Inorganic nitrogen (NO_2 + NO_3) shows low seasonal behavior, with high concentrations occurring throughout the year, though spring coincides with a period where fewer low concentration samples are taken, suggesting a groundwater input that leaches into these streams throughout the year with some increases occurring during spring application season.

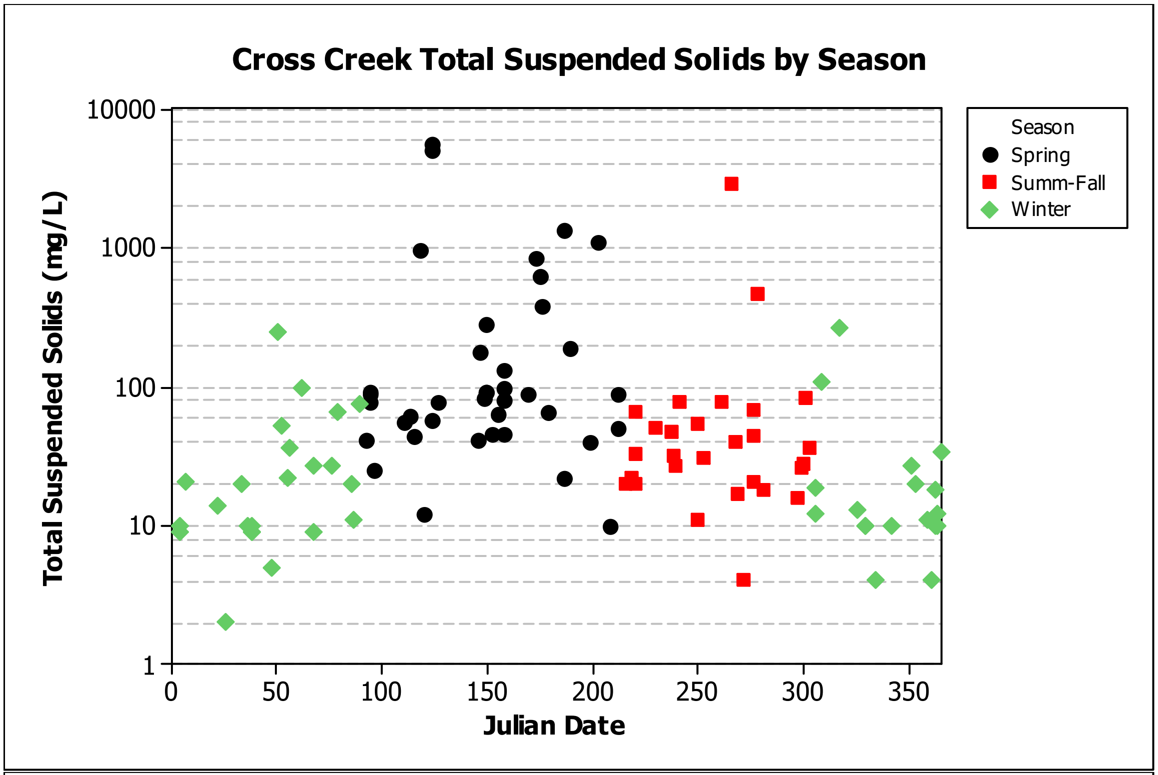
The strong seasonal nature of most of the contaminants suggests that measures targeting soil erosion, including stream bank stabilization, and buffering of streams from cropland will have large impacts. Bacteria appears to be an issue of limited concern in this watershed, as seasonal medians all fall below the most stringent contract recreation criteria for these streams. New data collected in accordance with current water quality criteria, which call for a 5 sample 30 day geometric mean, over the next few years should verify this conclusion. Long-term reductions in dissolved inorganic nitrogen levels may be produced by increased riparian buffer forest width. Once trees develop deep root systems that intercept groundwater flows reductions in inorganic nitrogen loads can be expected. Long-term results may occur with increased use of soil testing to ensure that fertilizer application rates do not exceed crop needs.

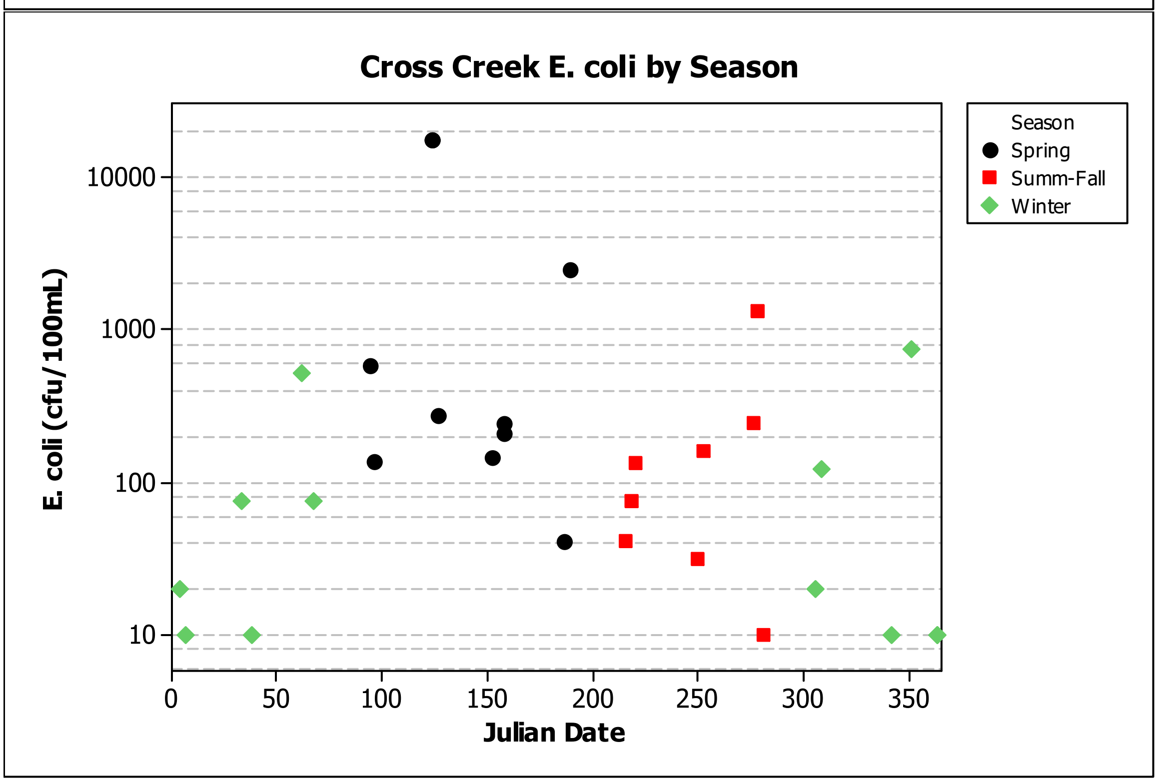
	TP Median	TSS Median	Turbidity Median	TOC Median	Kjeldahl Median	*E.coli* Median	TN Median
Overall	0.105 (107)	38.5 (108)	18 (108)	5.1775 (44)	0.605 (51)	127.5 (30)	1.42 (51)
Spring	0.155 (38)	84 (39)	34 (39)	6.506 (17)	0.671 (19)	256.5 (10)	1.59 (19)
Summer Fall	0.1015 (28)	32.5 (28)	18 (28)	4.462 (11)	0.535 (12)	104.5 (8)	1.2995 (12)
Winter	0.067 (41)	13 (41)	6 (41)	4.6295 (16)	0.4925 (20)	20 (12)	1.383 (20)

Numbers in parenthesis indicate sample size.


Cross Creek Total Phosphorus Concentrations by Season
Total Phosphorus (mg/L)
1.00
0.10
0.01
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter

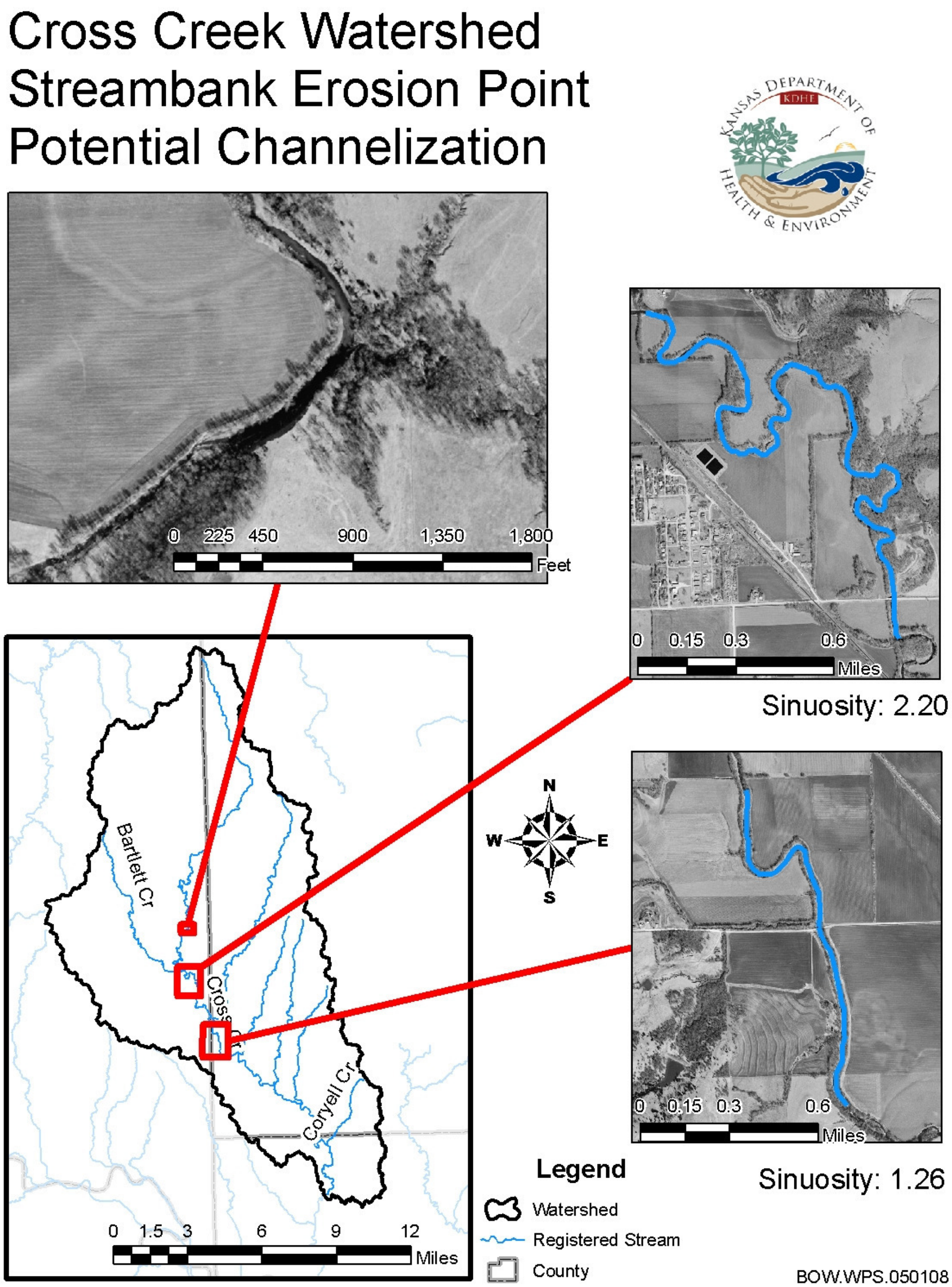

Cross Creek Total Nitrogen Concentrations by Season
Total Nitrogen (mg/L)
10
1
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter





Streambank stabilization may play an important role in improving water quality in the Clarks Creek watershed. One meter resolution aerial photographs were used to identify a number of potential unstable streambanks in the lower reaches of the watershed.

Inspection of stream channel sinuosity also suggests that channelization has occurred, and may be contributing to the observed water quality.



Uncertainty-

Because no gage data are available concurrently with the stream chemistry data, some uncertainty exists about the flow conditions associated with the samples. Very large

TSS values likely occurred during very high flow events, which may be less responsive to restoration efforts (Meals, 1990). Previous research (unpublished) by KDHE has indicated that median values are strong descriptors of nutrient related impairments, even in the absence of flow data, when large sample records exist. At this level of analysis it is not possible to determine the relative contributions of overland flow and in-stream processes, including collapsing streambanks. Elevated nitrogen levels could also be indicative of failing on-site wastewater systems, which cannot be ruled out as a potential contributor at this level of analysis. Future restoration efforts in this area would benefit from more water quality data throughout the watershed, to pinpoint potential sources of pollution, and better define the spatial and temporal variation in water quality. Additionally, surveys of stream channel morphology will locate potential sources of major bank instability.

Adaptive Implementation Strategies-

Because this stream exhibits characteristics that are consistent with both overland flow and unstable streambank sources, initial efforts could be focused on the lower reaches of Cross Creek and Coryell Creek. This watershed epitomizes the use of alluvial valleys for row crop production, and shows some signs of poor buffering around the streams. While forest buffers along major streams are present throughout the watershed, the buffers tend to be narrow, and would benefit streams more with additional width. The moderate TP concentrations appear to track the loading pattern of TSS, suggesting improvements in conservation practices may reduce both of these contaminants. Preservation and expansion of the existing buffer zone will likely have beneficial effects for all pollutants for many years to come. Some evidence of terracing is apparent from aerial photography, which can reduce erosion on steeply sloping soils. Evaluation of overall condition of existing terraces may identify areas where rebuilds are needed to ensure proper functioning. Placement of grassed waterways and other upland erosion control measures may also reduce the concentrations of TSS in Cross Creek and its tributaries. While permanent grassland is the major land use in this watershed, a large portion of that grass is pasture/hay, rather than grazing land. Little research has been done on the impacts of pasture land uses in Kansas, and a more detailed evaluation of the management of these lands may be helpful in understanding sources of pollution.

Cross Creek has had a number of historically notable floods. As recently as October 2, 2005 portions of Rossville were under water. Flooding during the last few decades has led to consideration of constructing an earthen levy and re-location of the channel of lower Cross Creek. However, structural solutions have not been implemented because of community concerns related to costs. Some strategies that would improve water quality, such as off-channel storage in riparian wetlands, may provide some level of protection by reducing the peak discharge volumes traveling down Cross Creek. It is likely such low-lying wetlands existed historically, and their re-establishment may offer an opportunity to improve water quality while reducing risks associated with intermittent flooding. Further study of this option will be required to determine costs and viability.

Because riparian buffering activities typically take three or more years to fully establish themselves, monitoring of post-implementation water quality should be a long-term objective. The existing monitoring record is unlikely to have many high-flow events, due to the design of the sampling program. Because the majority of loads of suspended solids and total phosphorus are likely to occur during a few, relatively large events, a before-and after- sampling program focused on high flow events would determine if efforts lead to significant improvements to water quality. Nitrogen concentrations appear to be less variable than TSS and TP, though concentrations still exceed regional guidance by large amounts, year round. Wintertime concentrations that usually exceed summer-fall concentrations suggest that groundwater loading is a probable source of nitrogen, because wintertime flows are typically driven by baseflow from groundwater sources, while some dilution may be occurring during summer when flows are usually somewhat higher than winter flows.

It should be noted that some strategies to reduce nutrient pollution have confounding effects. Tillage and cover strategies that reduce runoff and increase infiltration have been documented in some cases to increase nitrogen infiltration to groundwater. Increased infiltration should reduce phosphorus and sediment loading, and improvements to riparian forest areas are likely to reduce groundwater loading of nitrogen to the stream, while increasing bank stability. Therefore, implementing strategies should target field runoff for sediment and phosphorus loading, and simultaneously implement riparian restoration.

Should streambank stabilization, riparian planting, and other buffering activities in the lower reaches not reduce sediment and nutrient loading to acceptable levels, targeted monitoring may be required to determine sources more accurately. Funding for practices to improve water quality should focus on lands adjacent to streams where cropland is completely unbuffered, and implementation of erosion control practices in the valley along Cross Creek, because these areas are more likely to contribute to water quality problems monitored at station 551.

Cross Creek presents moderate challenges to implementation of protection and expansion of the existing riparian buffer, which has significant potential to improve water quality. While unverified at this level of analysis, the low sinuosity of some of the mainstem segments of Cross Creek suggests that channelization has occurred in this area, and unstable banks may be contributing to the concentrations observed. Increasing the streams' connection with its flood plain and widening of permanent vegetation buffers along the streams could require some reductions of current cropland uses by area landowners. Further evaluation will need to be completed to determine the extent of the problem, and establish the costs for implementing conservation activities.